POTENSI TANAH GAMBUT, BATU KAPUR, ZEOLIT DAN KARBON TERAKTIF SEBAGAI PENJERAP KOMPOSIT UNTUK MERAWAT LARUT RESAPAN

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Tesis ini dikemukakan sebagai
memenuhi syarat penganugerahan
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ABSTRAK

Matlamat utama kajian ini adalah untuk menghasilkan bahan komposit baharu yang terdiri daripada tanah gambut, batu kapur, zeolit dan karbon teraktif sebagai bahan mentahnya untuk menjerap ammonia-nitrogen (NH_3-N) dan permintaan oksigen kimia (COD) secara serentak dari larut resapan stabil. Tahap kehidrofobikan (penolakan air) ditentukan melalui kaedah masa penembusan titik air (WDPT) dan sudut sentuhan air (WCA) untuk tanah gambut, batu kapur, zeolit dan karbon teraktif. Nisbah optimum dijalankan melalui ujikaji penjerapan kelompok. Simen Portland biasa (OPC) digunakan sebagai bahan pengikat sebanyak 40 peratus (mengikut berat). Tanah gambut dan karbon teraktif dikategorikan sebagai penjerap hidrofobik di mana nisbah optimum adalah 1.5:2.5. Batu kapur dan zeolit dikategorikan sebagai penjerap hidrofilik di mana nisbah optimum adalah 15:25. Nisbah optimum untuk penjerap hidrofobik dan hidrofilik telah dipilih sebagai 4:4 sesuai dengan tingkah laku penjerapan NH_3-N dan COD ke atas penjerap. Pencirian penjerap komposit telah dilakukan dengan menggunakan pendarkilau sinar-x (XRF), spektroskopi inframerah transformasi (FTIR), mikroskop imbasan elektron (SEM), luas permukaan Brunauer Emmett Teller (BET), titratan Boehm dan pH di caj titik sifar (pH_{zpc}). Analisis XRF bagi penjerap komposit menunjukkan kehadiran kalsium oksida dan silika oksida yang tinggi sebagai sebatian utama. Kumpulan-kumpulan berfungsi utama dalam penjerap komposit adalah O-H, N-H, O-C, C-N, C-O dan Si-O-Si. Analisis SEM mendedahkan bahawa penjerap komposit mempunyai permukaan liang yang heterogen dan kasar. Luas permukaan BET penjerap komposit adalah 105.96 m^2/g. Kumpulan berfungsi permukaan jelas menunjukkan bahawa jumlah kumpulan asas lebih tinggi daripada jumlah kumpulan berasid. pH_{zpc} untuk penjerap komposit adalah pada pH 11.25 di mana caj permukaannya adalah seimbang. Kesan kelajuan goncangan, masa sentuhan, pH, saiz partikel dan dos penjerap pada penyingkiran NH_3-N dan COD telah diukur. Penjerap komposit telah digunakan dalam kajian isoterma penjerapan NH_3-N dan COD dalam larut resapan

Simpang Renggam pada keadaan optimum kelajuan goncangan 200 rpm, masa sentuhan 120 minit, pH 7 dan saiz partikel 2.36-3.35 mm. Kapasiti penjerapan untuk kesemua parameter (dalam mg/g) masing-masing 26.18 dan 47.39. Kajian perbandingan menunjukkan kapasiti penjerapan penjerap komposit terhadap NH_3-N dan COD adalah lebih baik daripada zeolit dan karbon teraktif. Kajian kinetik penjerapan mendapati penjerap komposit mengikut hampir kesemua model yang dikaji iaitu pseudo-tertib pertama, pseudo-tertib kedua, Elovich dan pembauran intra-partikel dengan model pseudo-tertib kedua adalah paling dominan untuk keseluruhan parameter. Keadaan ini menunjukkan kemungkinan penentu langkah kawalan kadar adalah secara penjerapan kimia. Kajian penjerapan turus lapisan tetap menunjukkan penyingkiran sebanyak 99% untuk NH_3-N manakala 98% untuk COD. Kapasiti bulus dan masa tepu didapati makin berkurangan dengan berlakunya peningkatan terhadap kadar aliran. Data ujikaji lebih mengikut model Thomas dan model Yoon-Nelson berbanding model Adams-Bohart. Penjerap komposit boleh digunakan semula selepas menjana semula dengan larutan NaCl 0.5 M pada pH 12 (dilaras dengan NaOH 1 M) dengan kapasiti penjerapan NH_3-N dan COD (dalam mg/L) masing-masing 34.13 dan 33.22. Oleh itu, penjerapan NH_3-N dan COD ke atas penjerap komposit yang didorong oleh tanah gambut, batu kapur, zeolit dan karbon teraktif mempunyai potensi yang besar untuk rawatan larut resapan stabil dari tapak pelupusan.

ABSTRACT

The aim of this study was to produce a novel composite material made up of peat, limestone, zeolite and activated carbon as a starting material for adsorbing ammonia-nitrogen (NH_3-N) and chemical oxygen demand (COD) simultaneously from stabilized landfill leachate. The level of hydrophobicity was measured by the water drop penetration time (WDPT) and water contact angle (WCA) method for activated carbon, peat, zeolite and limestone. The optimum ratio was predicted by mean of a batch equilibrium experiments. Ordinary Portland cement (OPC) was used as a binder at 40 percent by weight. Activated carbon and peat was grouped as a hydrophobic adsorbent where the optimum ratio was 2.5:1.5. Zeolite and limestone was in hydrophilic adsorbent group which the best ratio was 25:15. The ratio for hydrophobic and hydrophilic adsorbent had been chosen as 4:4 accordingly to adsorption behavior of NH_3-N and COD to the media. Characterization of composite adsorbent were done using x-ray fluorescence (XRF), fourier transform infrared (FTIR), scanning electron microscopy (SEM), Brunauer Emmett Teller (BET) surface area, Boehm titration and pH at zero-point charge (pH_{zpc}). The XRF analysis of composite adsorbent shows the high presence of calcium oxide and silica oxide as main compound. The main functional groups in the composite adsorbent were O-H, N-H, O-C, C-N, C-O and Si-O-Si. The SEM analysis revealed that the composite adsorbent has heterogeneous pores and rough surface. The BET surface area of composite adsorbent was 105.96 m^2/g. Surface functional group clearly indicates that the total basic groups are slightly greater than the total acid groups. The pH_{zpc} experiment showing that at pH 11.25 its electric surface charge is zero. The effects of shaking speed, contact time, pH, particle size and adsorbent dosage on the adsorptive removal of NH_3-N and COD were quantified. The composite adsorbent was used in the isotherm study for NH_3-N and COD in Simpang Renggam leachate at optimum shaking speed of 200 rpm, contact time of 120 minutes, pH of 7 and 2.36–3.35 mm of particle size. The respective adsorption capacity for each parameter was 26.18 and

47.39 (mg/g) in respectively. Comparative study indicated that the adsorption capacity of composite adsorbent on NH_3-N and COD was higher than zeolite and activated carbon. Findings on the kinetic studies revealed that the composite adsorbent followed almost all the kinetic models namely pseudo-first order, pseudo-second order, Elovich and intra-particle diffusion, with pseudo-second order being the most dominant. It can be described that the possibility of the rate limiting step may be chemisorption. The column adsorption studies indicated that the removal can reach up to 99% for NH_3-N and 98% for COD. The breakthrough capacity and the saturation time decreased with the increase of flow rate. Thomas and Yoon-Nelson models gave better fit compared Adams-Bohart to the experimental data. Composite adsorbent was able to be reused after regeneration process using NaCl 0.5 M at pH 12 (adjusted by NaOH 1M) with adsorption capacites NH_3-N and COD were 34.13 and 33.22 (mg/g) in respectively. Consequently, the adsorption of NH_3-N and COD onto the composite adsorbent driven from peat, limestone, zeolite and activated carbon has a great potential for treatment of stabilized landfill leachate.

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